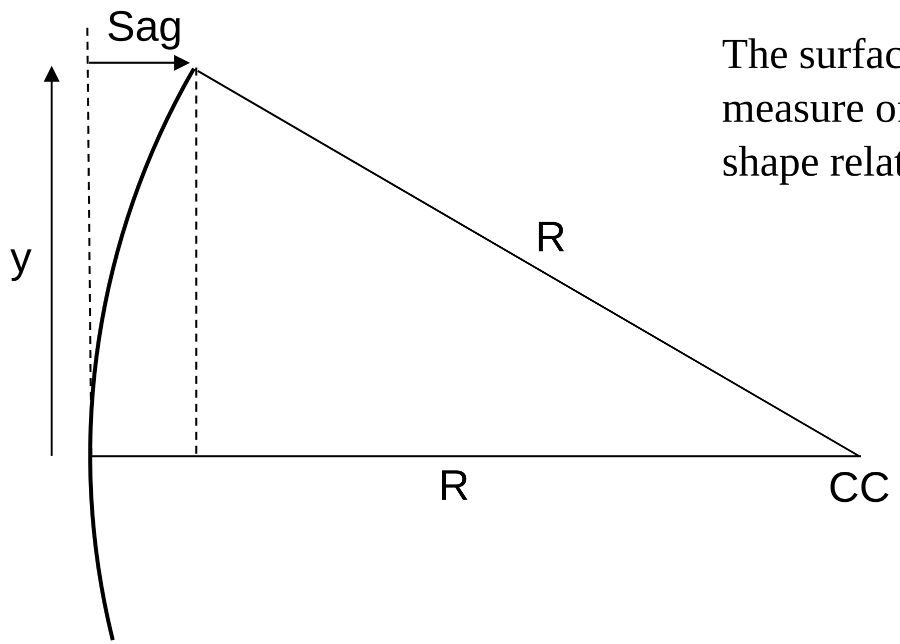
Section 24

Fabrication

Surface Sag



The surface sag is the measure of the surface shape relative to a plane.

Circle (or Sphere): $y^2 + \left(R - Sag\right)^2 = R^2$

$$y^2 + R^2 - 2R\,Sag + Sag^2 = R^2$$

$$Sag^2 << y^2$$

$$y^2 - 2R\,Sag \approx 0$$

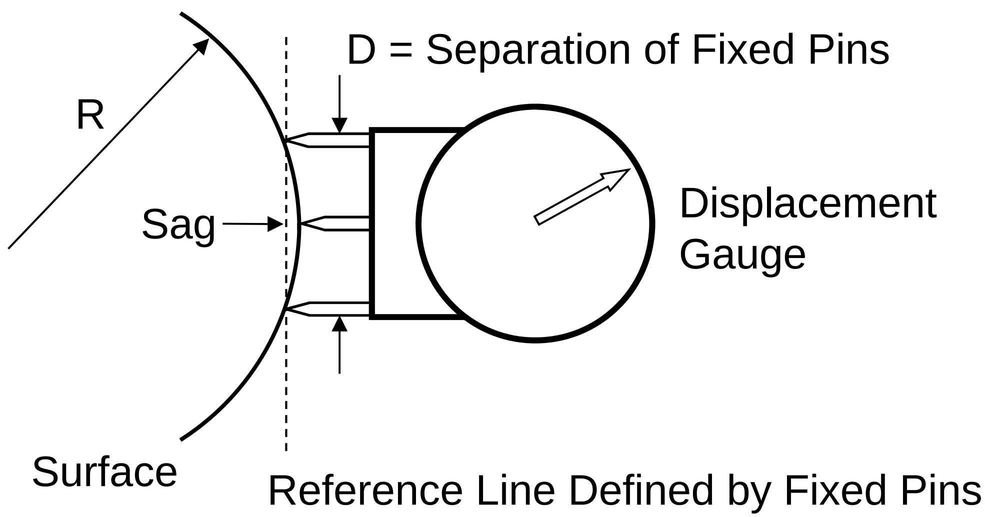
$$Sag \approx \frac{y^2}{2R}$$

This is the parabolic approximation for a circle or sphere.

Radius of Curvature Measurement

The surface sag over a fixed baseline is a common method of measuring radius of curvature in the optics shop.

The instrument is known as a Lens Clock or a Geneva Gauge. It consists of three pins that contact the surface. The outside two pins are fixed, separated by a distance D, and define a reference line. The middle pin is spring loaded and connected to a displacement gauge.



$$Sag \approx \frac{D^2}{8R}$$

$$R \approx \frac{D^2}{8\,Sag}$$

The gauge often reads in Diopters and assumes a specific index of refraction. A convex surface reads a positive power and a concave surface reads a negative power.

A spherometer is a more precise instrument for measuring Radius of Curvature. The surface is contacted with three fixed pins or a large ring. A micrometer in the center reads the sag of the surface relative to the plane defined by the three pins or the ring.

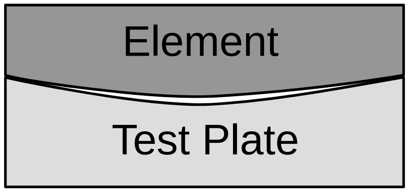
Surface Figure and Irregularity – Test Plates

The surface characteristics are usually measured interferometrically:

- Fizeau interferometer – Using a test Plate.
  - The specification is often given in fringes.
- Phase Shifting Interferometers – Higher precision test especially for irregularity.
  - The specification is often given in microns or waves.

Separate tolerances are given for radius of curvature (or power) and irregularity. The irregularity is often the cylindrical or toric component of the surface shape – it is a measure of non-rotational symmetry.

The irregularity is found by removing the spherical component of the surface error.



The Fizeau fringes represent the departure of the test surface from the shape of the reference. Each fringe represents a departure of a half wavelength.

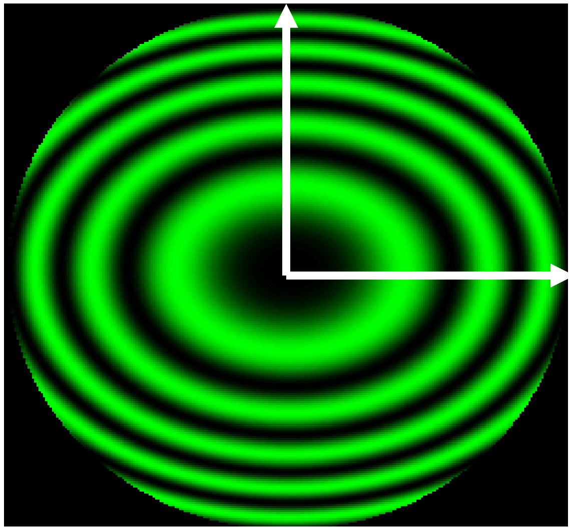
A typical surface specification on an optical surface measured with a test plate may be given as 3-1. Three rings (fringes) of power and one of irregularity.

Using Test Plates

When measuring power or irregularity, the bulls eye fringes should be centered.

Count the fringes in the long dimension and the short dimension:

- Power is the average of the two counts
- Irregularity is the difference of the two counts



Power fit = (5 + 3)/2 = 4 fringes

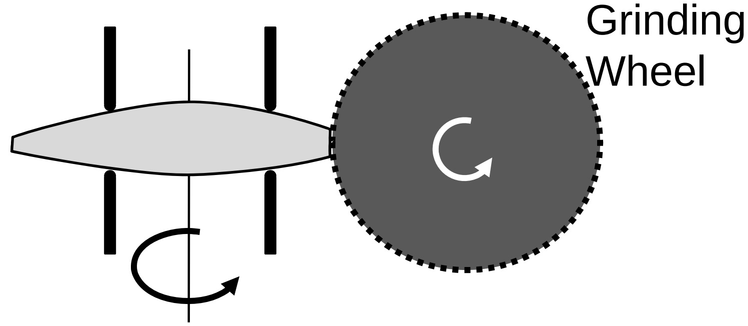
Irregularity = 5 – 3 = 2 fringes

Centering and Edging a Lens

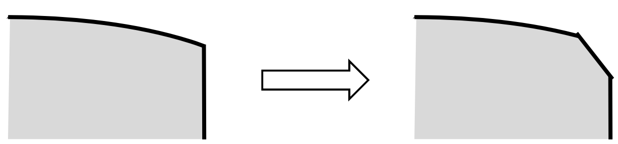
If a lens element is cupped or held between two aligned and opposing cylinders, the optical axis of the lens must align with the axis of the cylinders.

The edge of the lens can then be ground to produce a mechanical axis for the lens that is aligned with its optical axis.

The optical axis of the lens is aligned with the rotation axis.



To prevent chipping of sharp edges, edge bevels are usually ground as part of this centering operation.



The element centration and wedge can also be measured with the cupping arrangement using the total indicator runout.